

General Disclaimer

One or more of the Following Statements may affect this Document

- This document has been reproduced from the best copy furnished by the organizational source. It is being released in the interest of making available as much information as possible.
- This document may contain data, which exceeds the sheet parameters. It was furnished in this condition by the organizational source and is the best copy available.
- This document may contain tone-on-tone or color graphs, charts and/or pictures, which have been reproduced in black and white.
- This document is paginated as submitted by the original source.
- Portions of this document are not fully legible due to the historical nature of some of the material. However, it is the best reproduction available from the original submission.

LACIE-00417
JSC-10822

7.9 10120
TM-79984

LARGE AREA CROP INVENTORY EXPERIMENT (LACIE)

"Made available under NASA sponsorship
in the interest of early and wide dis-
semination of Earth Resources Survey
Program information and without implying
any use made thereof."



NASA NOAA USDA

WORST CASE SUN ELEVATIONS FOR LACIE II COUNTRIES

(E79-10120) LARGE AREA CROP INVENTORY
EXPERIMENT (LACIE). WORST CASE SUN
ELEVATIONS FOR LACIE COUNTRIES (NASA) 17 p
HC A02/MF A01 CSC1 02C

N79-18388

Unclas
G3/43 00120



National Aeronautics and Space Administration
LYNDON B. JOHNSON SPACE CENTER

Houston, Texas
FEBRUARY, 1976

NR 00-10120

WORST CASE SUN ELEVATIONS FOR LACIE II COUNTRIES

by

Richard L. Nance

February 1976

WORST CASE SUN ELEVATIONS FOR LACIE II COUNTRIES

Prepared by: Richard L. Nance
Richard L. Nance

Approved by: A. L. Grandfield
A. L. Grandfield, Deputy Chief
Research, Test, and Evaluation Branch

Worst Case Sun Elevations for LACIE II Countries

Introduction

With the initiation of LACIE II analysis, a larger proportion of segments will be located outside the United States. In particular, many more segments will be located in the U.S.S.R. There, the winter wheat average latitude is much higher than in the United States. One would expect lower Sun elevations at these higher latitudes. At some times during the year the lower Sun elevations could degrade classification. This report indicates the worst case Sun elevations for the LACIE II countries. This information should be of interest to all LACIE personnel.

Results

Figure 1 (which is fig. L-2 from the ERTS Data Users Handbook) gives for Landsat the Sun elevation history as a function of subsatellite latitude.

The lowest Sun elevation for a country will occur near the maximum latitude for that country, and the highest Sun elevation will occur near the minimum latitude. Therefore, the range of latitudes indicates the range of Sun elevations for a country. The maximum and minimum latitudes have been plotted on the previously mentioned figure for the seven countries under study in LACIE II.

Latitudes were plotted for the spring wheat in the United States (fig. 2a), the U.S.S.R. (fig. 2b), Canada (fig. 2c), and China (fig. 2d). There are no low Sun elevations at spring wheat segments because LACIE spring wheat segments are all in the northern hemisphere, and the spring wheat growth

period occurs at the time of year which is most favorable for Landsat Sun elevations in the northern hemisphere.

Latitudes were also plotted for winter wheat segments in the U.S. Great Plains (fig. 2h), U.S. Other (fig. 2e), U.S.S.R. (fig. 2f), Australia (fig. 2b), Argentina (fig. 2a), India (fig. 2c), China (fig. 2g), and Brazil (fig. 2h).

It can be seen from figures 2a to 2h that low Sun elevation will occur at some LACIE segments at some time during the year. The minimum Sun elevation required to achieve an acceptable classification accuracy is unknown; however, using Landsat data acquired at Sun elevations below 20° probably degrades classification accuracy. Certainly Sun elevations below 10° are unwelcome.

There are no Sun elevations below 20° at the winter wheat segments in India (fig. 2c), Brazil (fig. 2h), and China (fig. 2g), because of their low latitudes.

During biophase 1 (fall), there are Sun elevations below 20° at the winter wheat segments in Australia, Argentina, the United States, and the U.S.S.R. These would occur at the higher latitude winter wheat segments. There is no problem at lower latitude segments.

During biophase 1 (fall), Sun elevations below 10° occur at winter wheat segments in the northern U.S.S.R.

As Sun elevation decreases, the scene becomes darker. The scene brightness decreases as the sine of the Sun elevation because a constant cross section of energy from the Sun is spread over a larger area on the ground. Other effects which change brightness are (1) shadows become more common, (2) haze effects and (3) the path through the atmosphere

to the target is increased, which attenuates the illuminating energy. The lower scene reflectance decreases the statistical measures of the location of data; e.g., mean, along with the minimum and maximum. This effect can be compensated for by applying a Sun elevation correction to the data.

For a constant target, the lower scene reflectance decreases the range of the data values and there is also a loss of frequency in the data. The statistical measures of variation (e.g., standard deviation) decrease. The decrease in range causes a decrease in contrast in the imagery and an analogous change in data for machine classification. This decrease in range can be compensated for by a Sun elevation correction, while the loss of frequency in the data cannot be compensated for in this manner. This loss of frequency is what degrades classification. The amount of degradation is difficult to quantify because there are few constant targets. Most targets change with seasonal vegetative changes and with temporal changes (e.g., soil moisture). Most low Sun elevations occur in the fall when contrast is already at a minimum because vegetation is sparse.

At most spring wheat segments, the Sun elevation changes only a few degrees over the growing season. However, there is a large change (e.g., 50 percent) in Sun elevation between the fall biowindow and the ripe biowindow for winter wheat. Therefore, a Sun elevation correction should be made before comparing fall and summer data; e.g., (1) the tasselled cap analysis where band 2 brightness is plotted against band 3 brightness over a growing season, (2) the MPAD Delta Plots, or (3) any analyses where brightness is compared.

The present method of computing gains and biases for imagery is relative, and no Sun angle correction is required. At present, the gains and biases for each segment are computed from the data in the 10- x 11-nautical-mile search area.

It has been suggested that absolute gains and biases be used (1) to avoid having to compute gains and biases, (2) to make the imagery more constant between segments, and (3) to avoid the problems one has with relative gains and biases if there are clouds or haze in the search area. One example of absolute gains and biases would be for each biowindow to have its own constant gains and biases. It now appears that a Sun elevation correction would have to be applied because of the variance in reflectance between segments caused by the variation in Sun elevation.

Summary

When there is a problem with low Sun elevations, the following conditions prevail: (1) it is a winter wheat segment, (2) the segment is at a "high" latitude, and (3) it is during biophase I (fall). The primary, secondary, and tertiary problems with low Sun elevations are as follows:

- A. The primary problem with low Sun elevations is in the U.S.S.R. This is because the winter wheat segments in the U.S.S.R. are so far north.
- B. The secondary problem with low Sun elevations is in Argentina and Australia.
- C. The tertiary problem with low Sun elevations is in the United States. A small number of segments are involved because most winter

wheat in the United States is grown at southern or central latitudes.
Most wheat in the northern United States is spring wheat.

Recommendations

It is recommended that a study be performed to quantify the effect of low Sun elevations on LACIE classification. In addition, if there is a Sun elevation below which data are not useable, then those data should not be acquired.

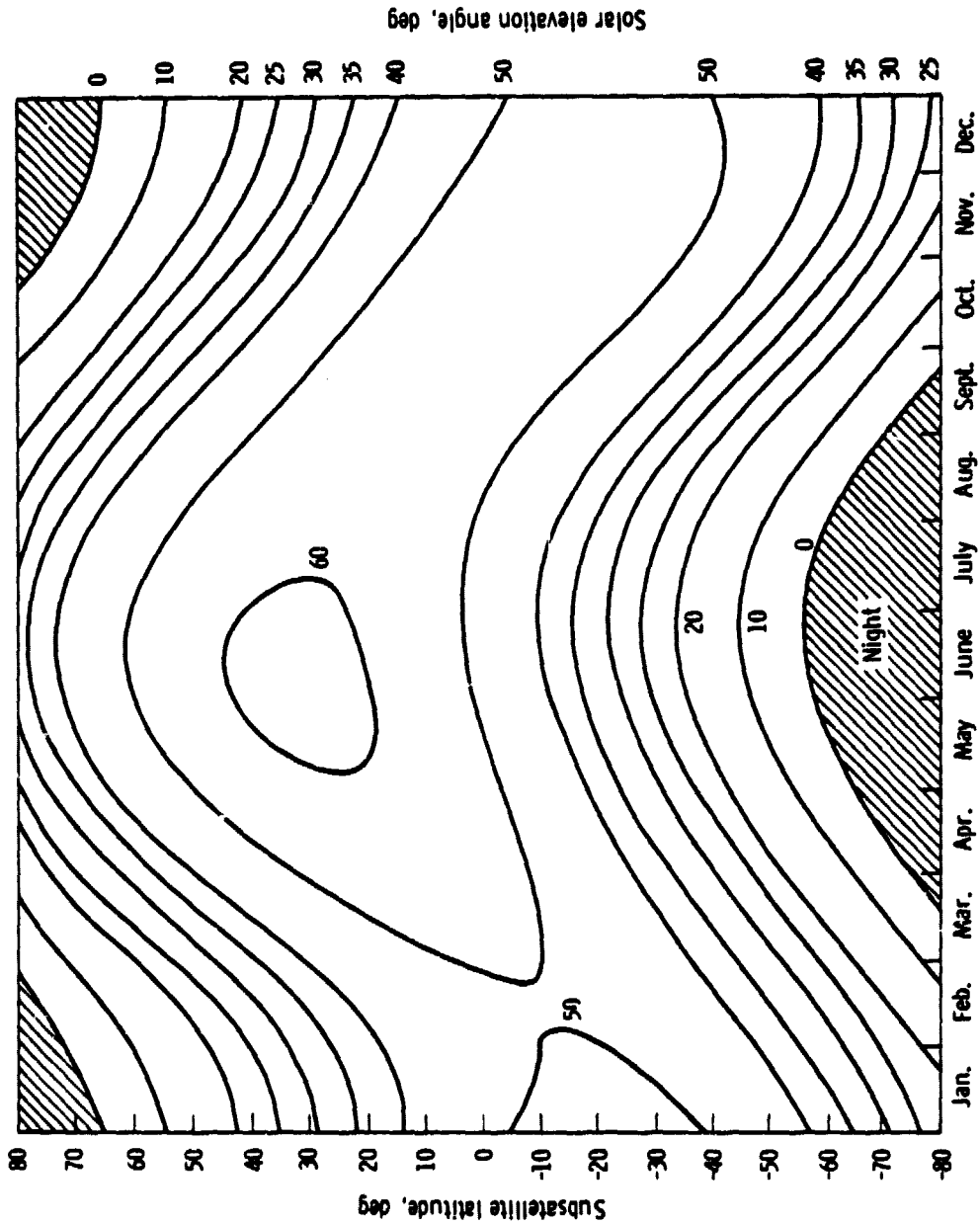
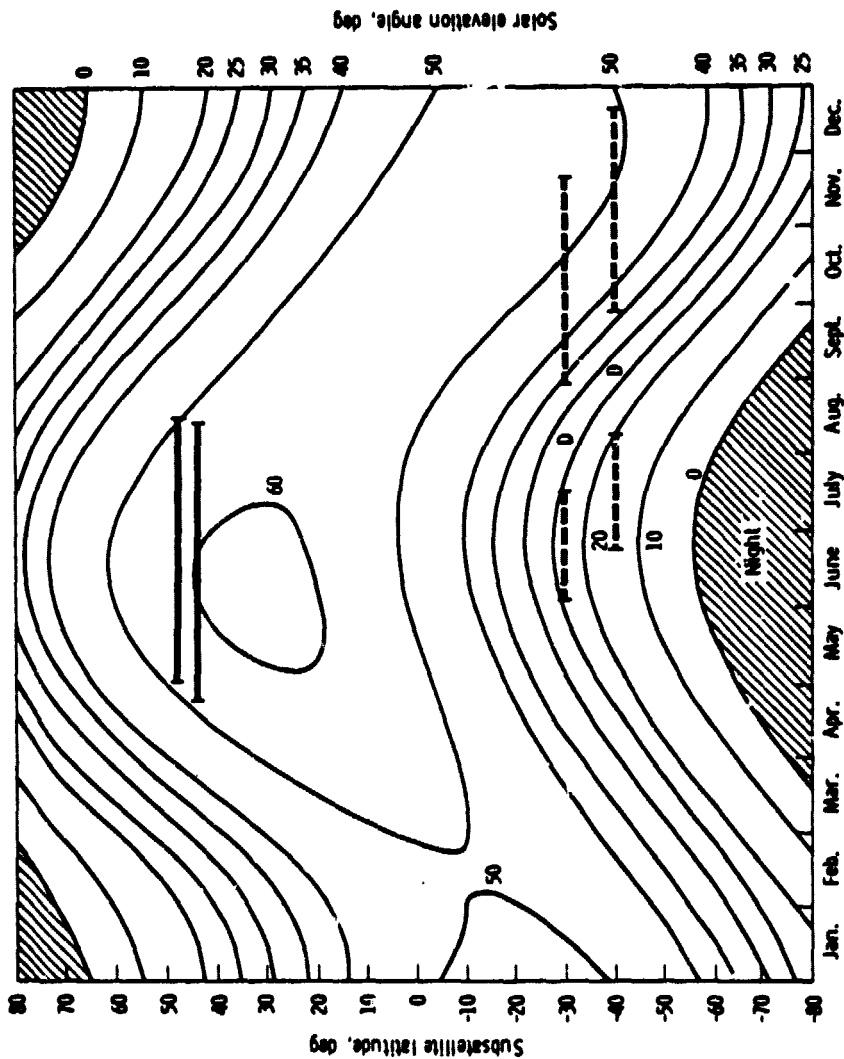
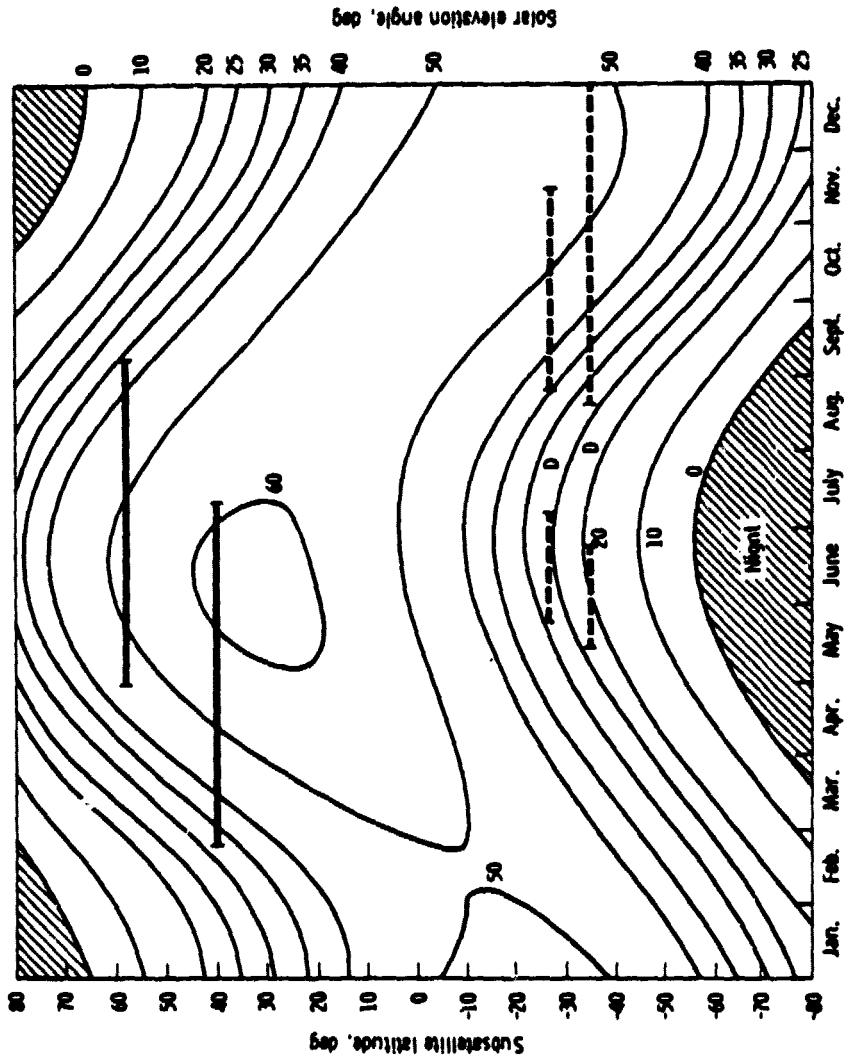


Figure 1.- Sun elevation history as a function of subsatellite latitude for Landsat.



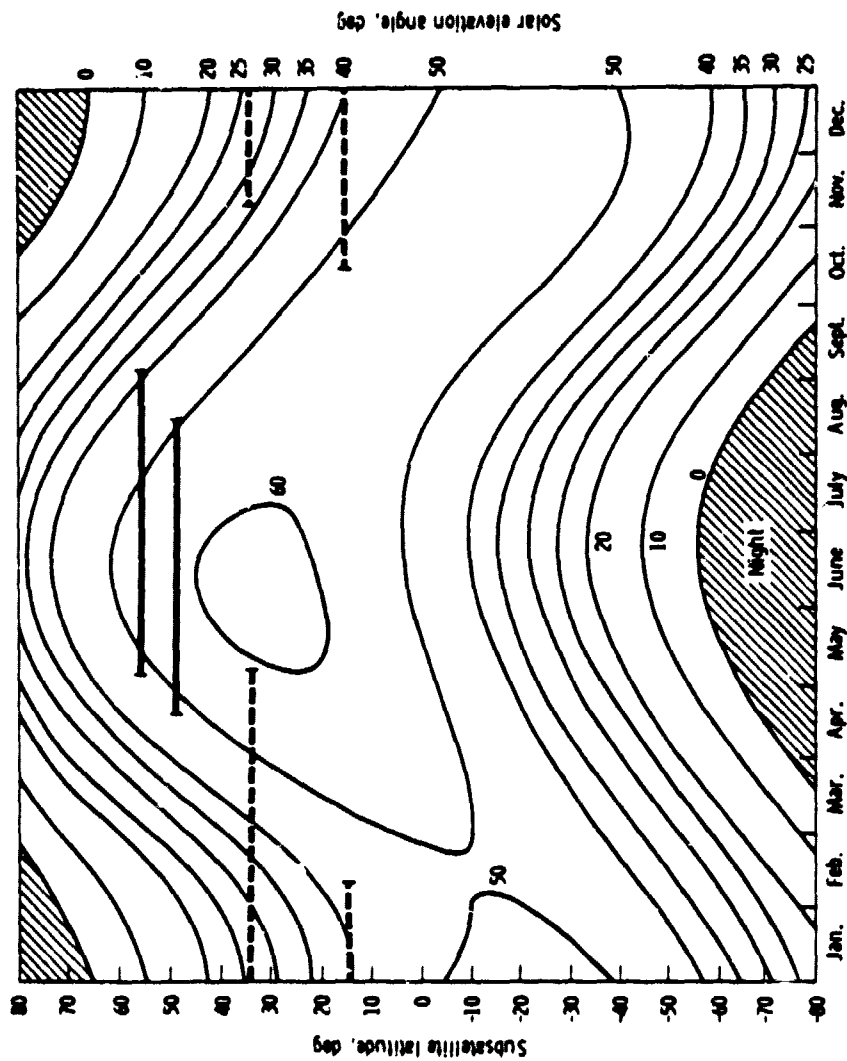
(a) U.S. Great Plains spring wheat (represented by solid lines; maximum latitude is 48°; minimum latitude is 44°) and Argentina winter wheat (represented by dashed lines; maximum latitude is 40°; minimum latitude is 30°; D = dormancy).

Figure 2.- Solar elevation angle history as a function of subsatellite latitude. Descending node at 9:30 a.m.



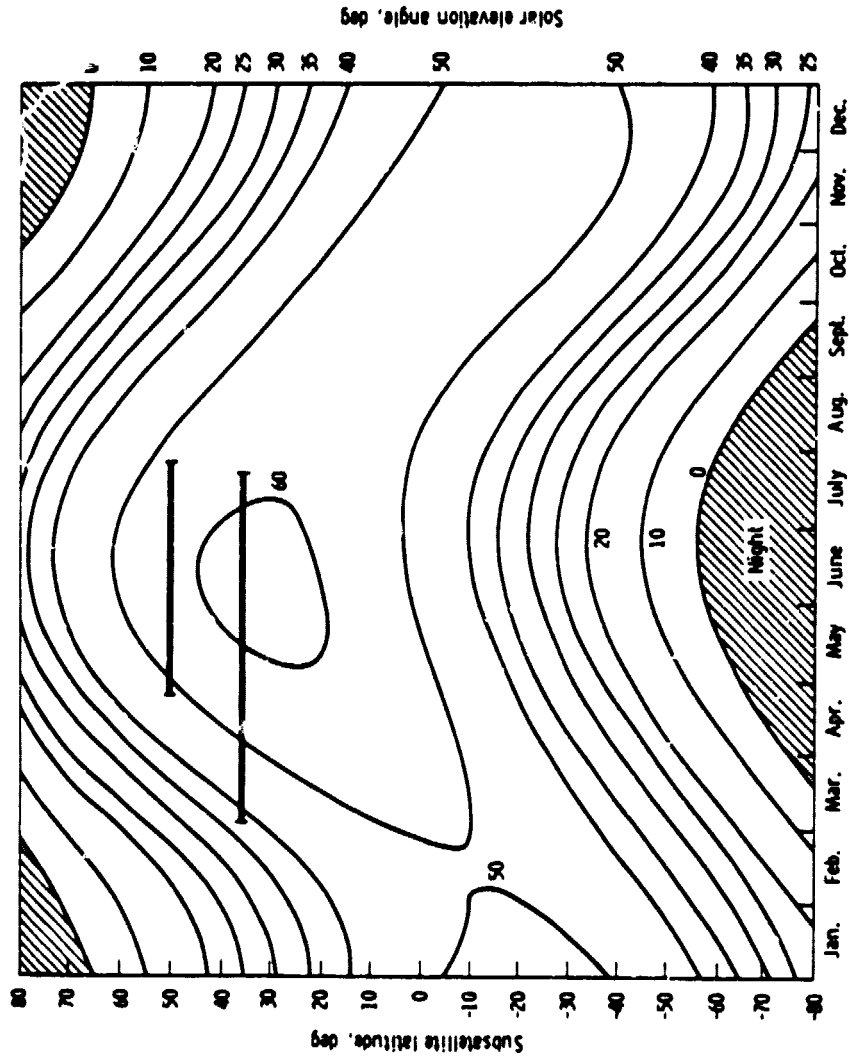
(b) U.S.S.R. spring wheat (represented by solid lines; maximum latitude is 59°; minimum latitude is 40°) and Australia winter wheat (represented by dashed lines; maximum latitude is 35°; minimum latitude is 27°; D = dormancy).

Figure 2.- Continued.



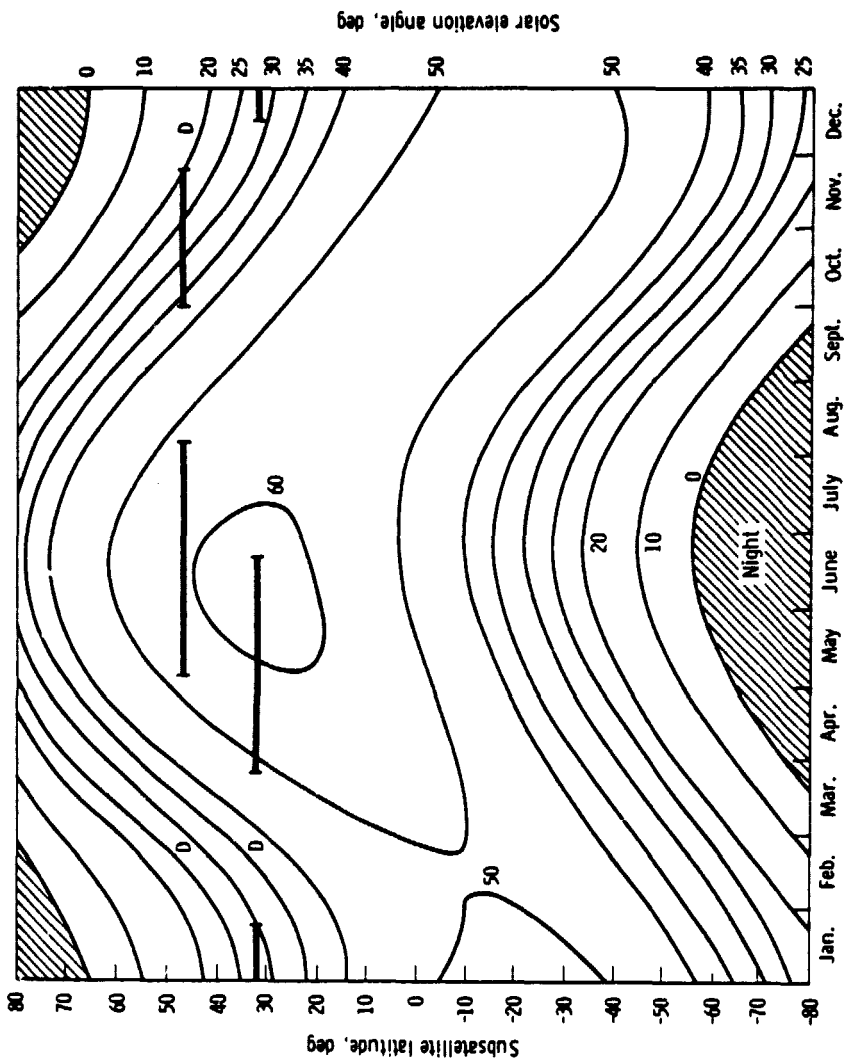
(c) Canada spring wheat (represented by solid lines; maximum latitude is 56°; minimum latitude is 49°) and India winter wheat (represented by dashed lines; maximum latitude is 34°; minimum latitude is 15°).

Figure 2.- Continued.



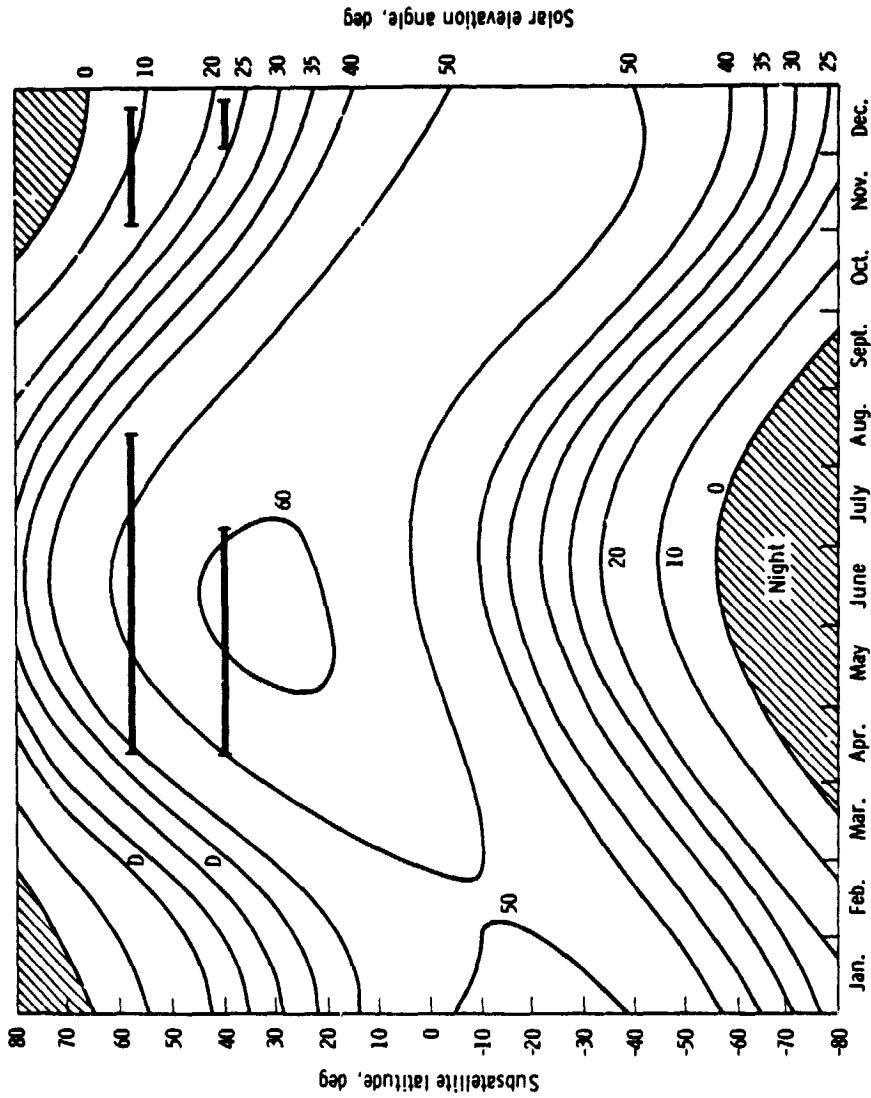
(d) China spring wheat Intensive Test Sites (maximum latitude is 50°; minimum latitude is 36°).

Figure 2.- Continued.



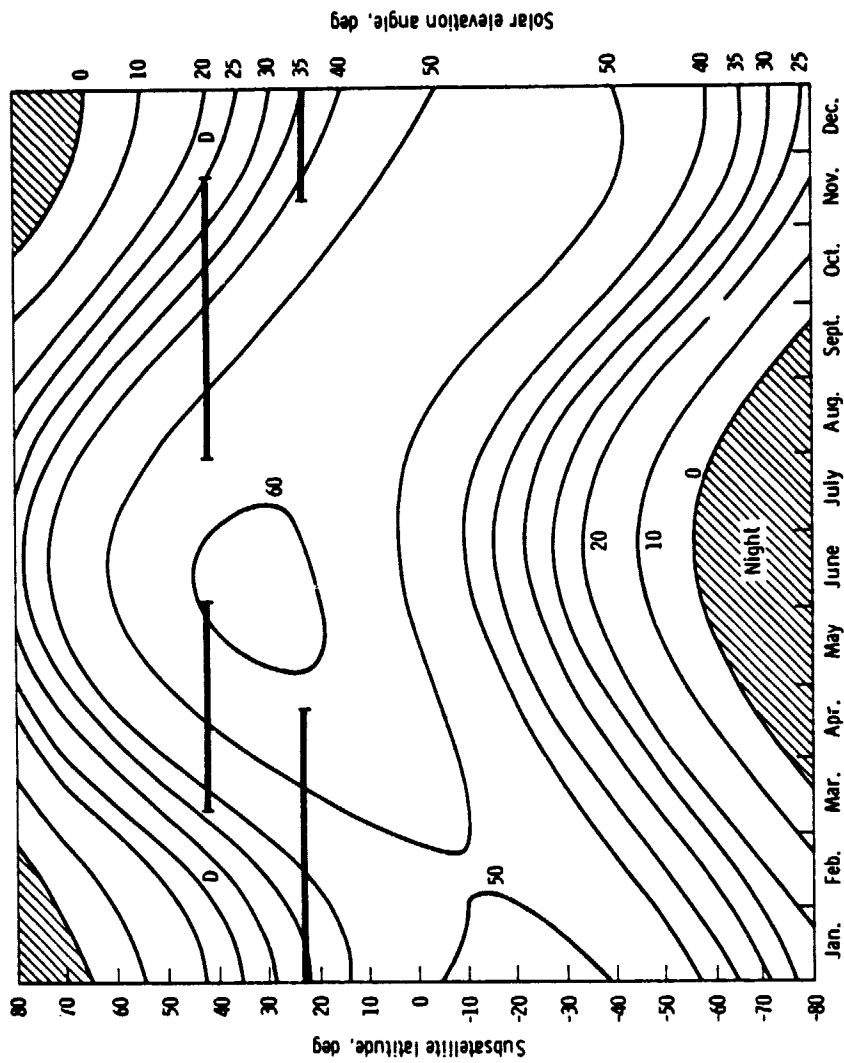
(e) U.S. winter wheat, other (maximum latitude is 47°; minimum latitude is 32°; D = dormancy).

Figure 2.- Continued.



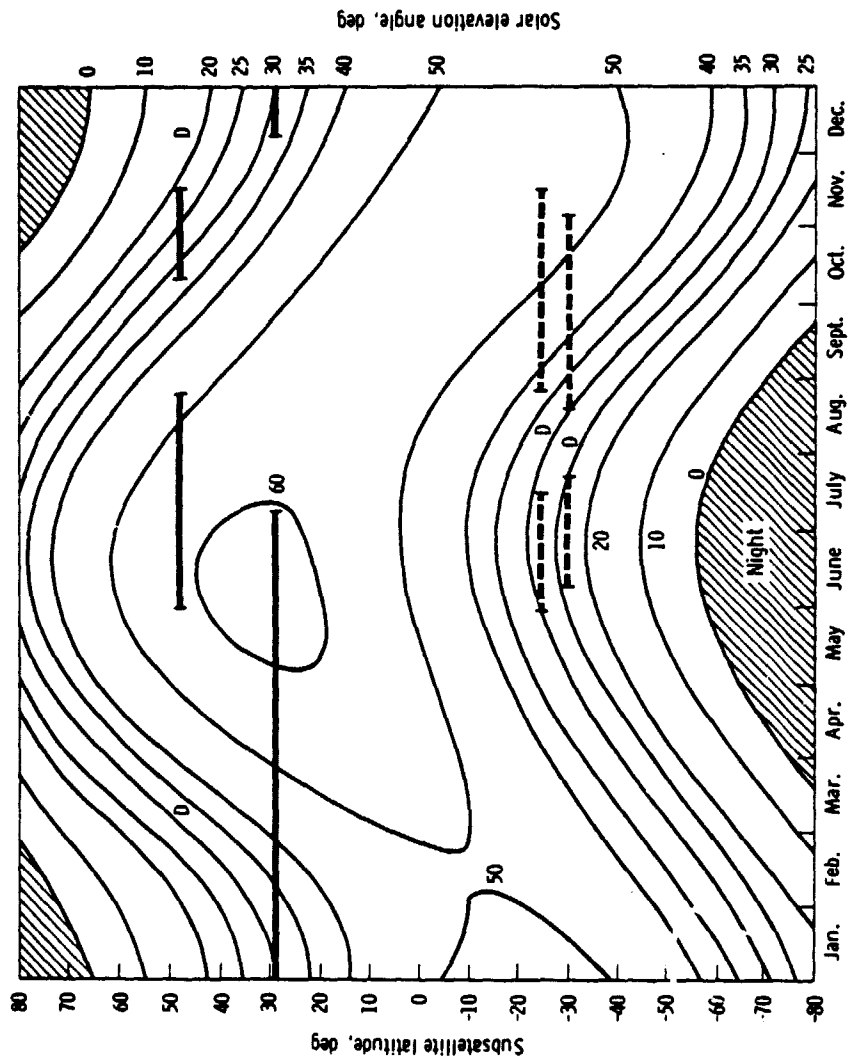
(f) U.S.S.R. winter wheat (maximum latitude is 58°; minimum latitude is 40°;
 D = dormancy).

Figure 2.- Continued.



(g) China winter wheat Intensive Test Sites (maximum latitude is 42°; minimum latitude is 23°; D = dormancy).

Figure 2.- Continued.



- (h) U.S. Great Plains winter wheat (represented by solid lines; maximum latitude is 48°; minimum latitude is 29°; D = dormancy) and Brazil winter wheat (represented by dashed lines; maximum latitude is 30°; minimum latitude is 25°; D = dormancy).

Figure 2.- Concluded.